RGM-3000/REB-3000

Operational Manual

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RoyalTek GPS Module: RGM-3000/REB-3000101 Operational Manual

RoyualTek GPS Module:

RGM-3000/REB-3000

Operational Manual

Introduction

RGM-3000/REB-3000 is the third generation of RoyalTek GPS Receiver. RGM-3000(E,M) consists of active antenna and GPS receiver. REB-3000(or RGM-3000L) consists of GPS receiver without active antenna. The GPS receiver is powered by SiRF Star II technology and RoyalTek proprietary navigation algorithm that providing you more stable navigation data. The miniature design is the best choice to be embedded in a portable device like PDA, mobile phone, person locator and vehicle locator. It supports TricklePower function which can be enabled by external command for power saving. The excellent sensitivity of RGM-3000 gets the great performance when going though the urban canyon and foliage.

Product Features

RGM-3000/REB-3000

- OEM product development is fully supported through applications engineering and WEB technique forum.
- Small form factor.
- 12 parallel channels
- 0.1 second re-acquisition time.
- Enhanced algorithm for navigation stability.
- NMEA-0183 compliant protocol/custom protocol.
- WAAS demodulator
- Excellent sensitive for urban canyon and foliage environments.
- Single satellite positioning.
- Dual multi path rejection.
- Data-log capability – At least 1 Mega-bits memory space will be implement in the product

Product applications

RGM-3000/REB-3000

- Portable IA device for personal navigation/ position commerce (P-Commerce)
- Automotive applications
- Personal positioning and navigation
- Marine navigation
- Timing application
- **Extendable I/O capability – provide programming I/O function and development tool kit for customer**

Technique description

RGM-3000M, RGM-3000E

General information. The RGM-3000 is a stamp size GPS receiver with an active antenna. It provides the antenna power through RF cable. The default DC input of active antenna is 2.8 ~3.3V. Since it needs 3 satellites or more to do the first position fix. The suitable view angle of the active antenna is necessary. It will determine the first time position update after getting good satellites geometry. If the satellites are blocked, it may take time to determine the position. ***Caution: Please do not put any metal stuff on the antenna.*** It results in GPS receiver getting nothing. In urban canyon, the fast 0.1 second re-acquisition capability can make it determine the position right away through the cross-intersection.

REB-3000,RGM-3000L

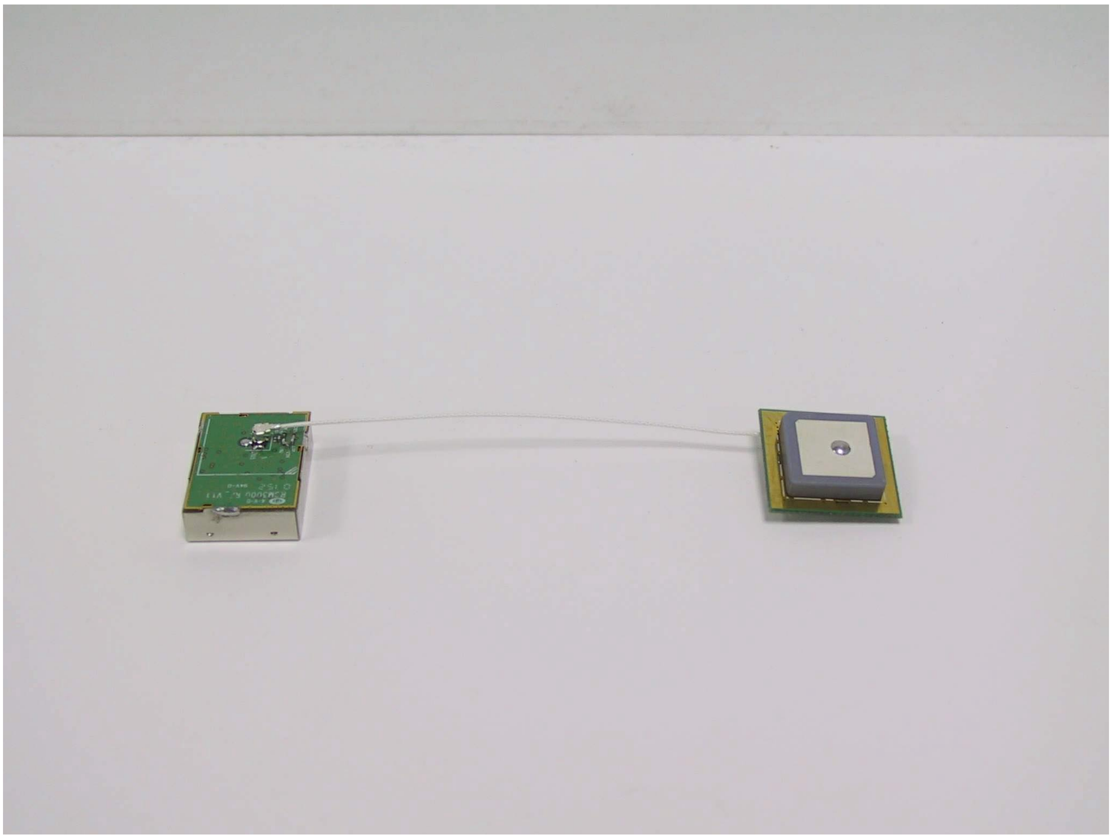
General Information. This is a stamp size GPS receiver without active antenna. It provides the external antenna power (2.8DCV ± 5%) through RF cable. There are 2 models for versatile antenna connectors:

1) RGM-3000L: with SMA RF cable.

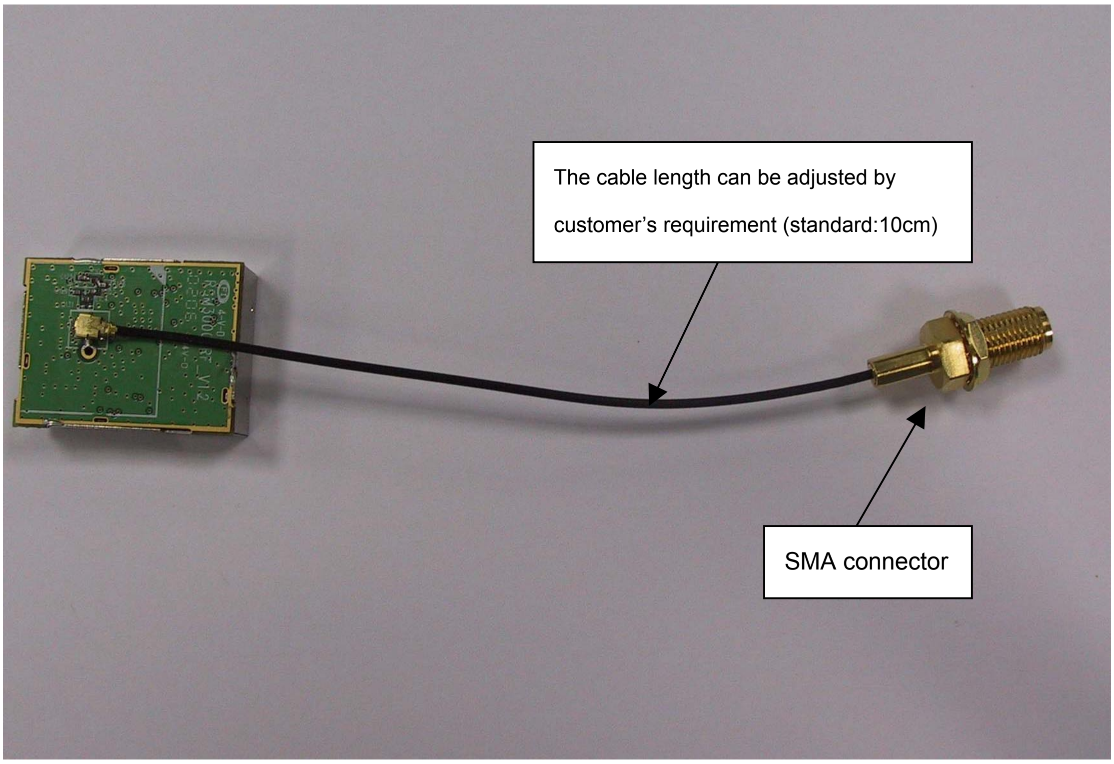
3) REB-3000: with HRS type of antenna connector (male) which you can connect to versatile types of antenna.

Picture

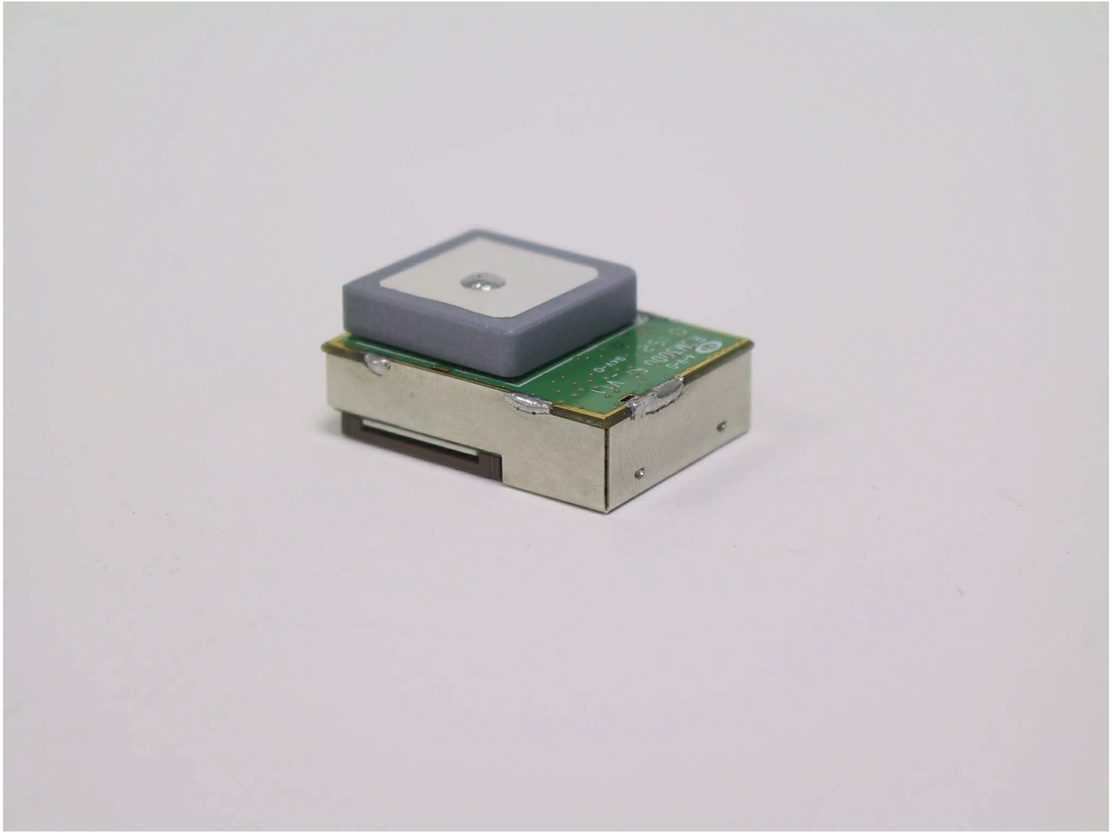
RGM-3000E



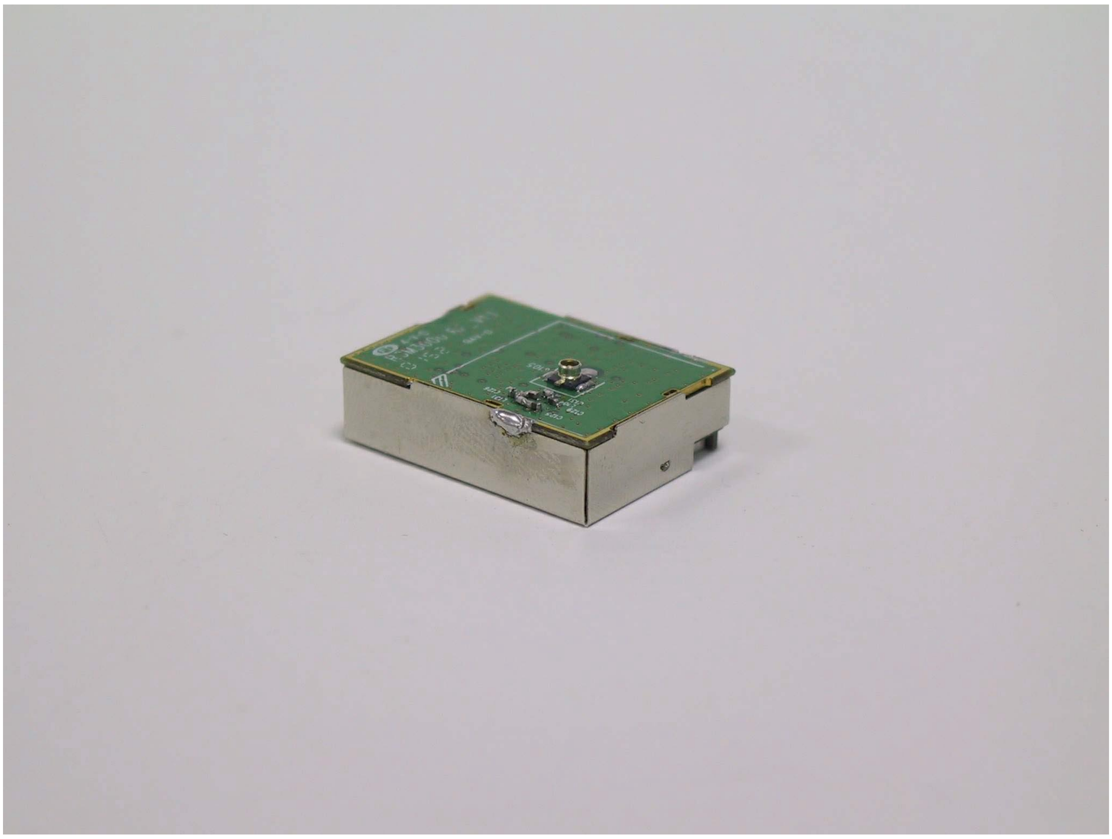
RGM-3000L



RGM-3000M



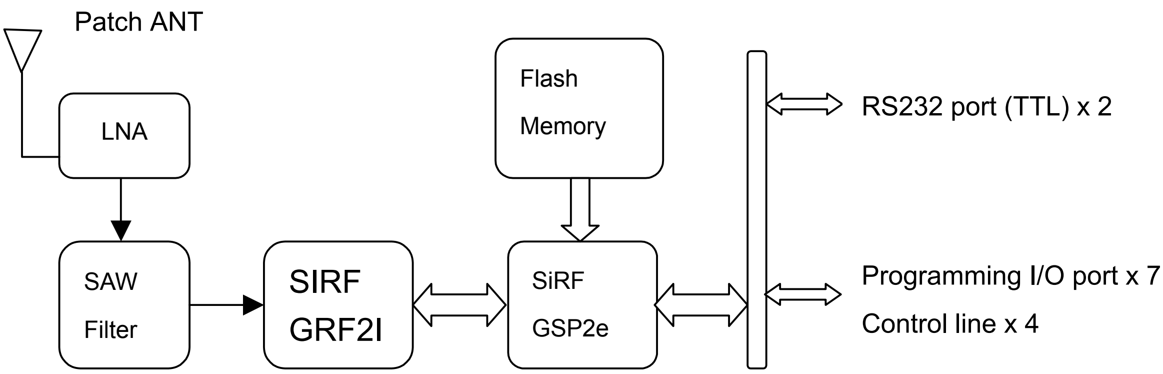
REB-3000



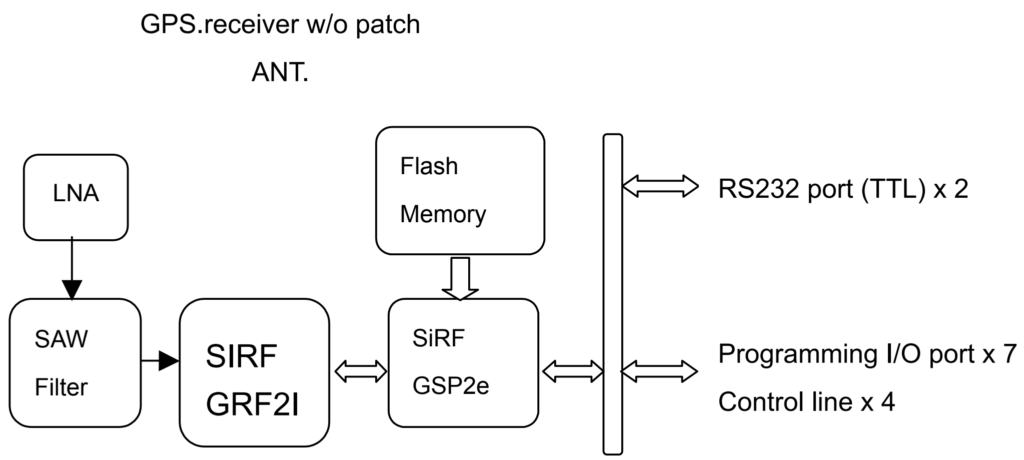
RGM-3000/REB-3000 Series System Block Diagram

The RGM-3000/REB-3000 series consists of SiRF star II chipsets technology, RoyalTek LNA and proprietary software. The system is described as follows.

RGM-3000M/RGM-3000E



RGM-3000L/REB-3000



Technique specifications

RGM-3000/REB-3000 series.

Operational Characteristics.

12 Channels

L1, 1575.42MHz.

C / A code, 1.023MHz chip rate.

Snap start: 3 seconds, typical

Hot start: 8 seconds, typical

Warm start: 40 seconds, typical

Cold start: 48 seconds, typical

Reacquisition:0.1 second, typical

Navigation update rate: Once per second.

Datum: WGS-84.

(The above specification is for standard version software . The specification for ES version of software may vary.)

Accuracy.

Position accuracy: 25m CEP without SA

Velocity accuracy:0.1 meters/second without SA

DGPS Accuracy.

Position:1 to 5 m, typical

Velocity: 0.05 meters/second, typical

Dynamics.

Altitude: 18000 meters (60000 feet) Max.

Velocity: 515 meters / second Max.

Acceleration: 4 g. , Max.

Power Requirements.

The input voltage is 3.3V±10%, ripple ≦ 200mV. The power of active antenna is supplied by RGM-3000/REB-3000 series. The full run (without trickle power) maximum current is less than 180mA.

Weight. 30g(RGM-3000),15g(REB-3000)

Environment.

Temperature.

Operating temperature -40 ~ +85 Degree (Celsius).

Storage temperature: -40 ~ +85 Degree (Celsius).

Humidity ≦95% noncondensing.

GPS Antenna Specification(RGM-3000E, RGM-3000M)

Center Frequency: 1575.42±1.023MHz

Bandwidth (-10dB return loss):9MHz min

Gain at Zenith: 3.0dBi Typ

Gain at 10° elevation :-1.0 dBi Typ

Polarization :R.H.C.P

Axial Ratio : 2.0dB max

LNA Specification:(External ANT for RGM-3000E)

Center Frequency: 1575.42±1.023MHz

Gain : 12dB Typ

Noise Figure : 1.8dB Typ

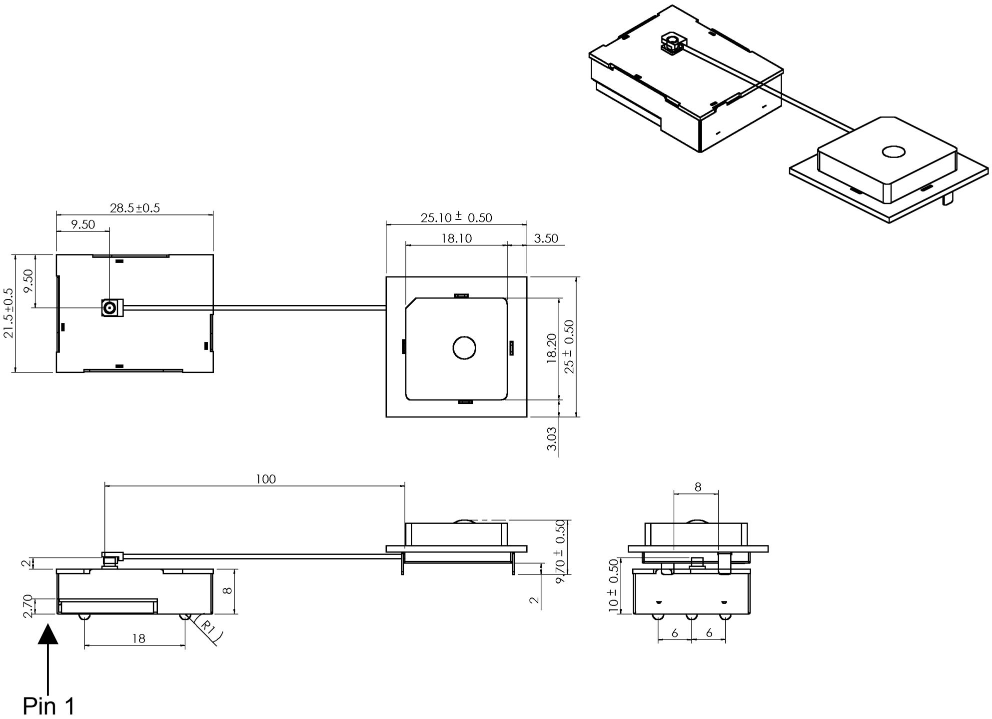
Out Band Attenuation : 7dB min for ±20MHz
20dB min for ±50MHz
30dB min for ±100MHz

Output V.S.W.R	2.0dB max
Voltage	DC 2.8.0±0.5V
Current	12mA max

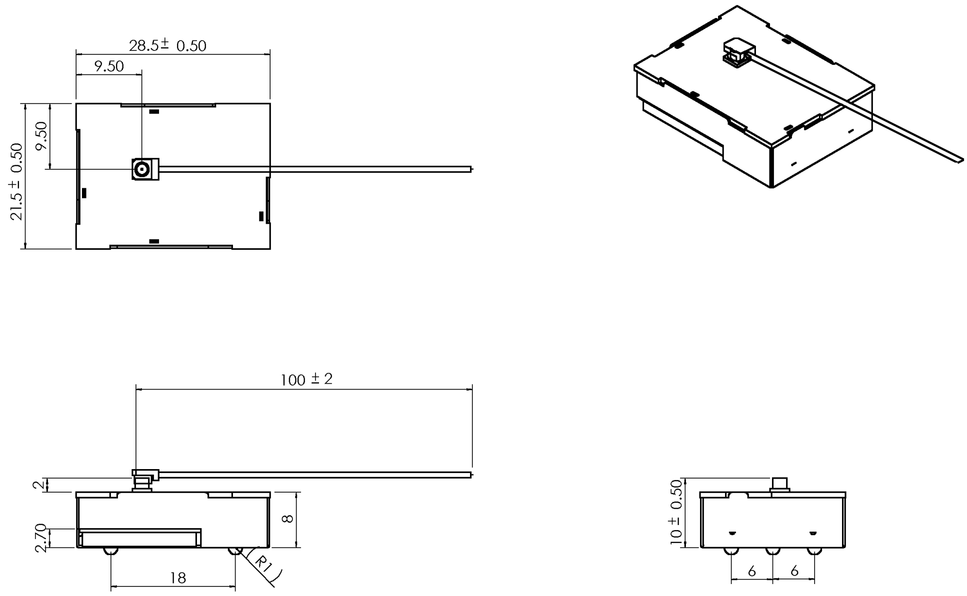
Mechanical Layout

RGM-3000/REB-3000 Mechanical Layout

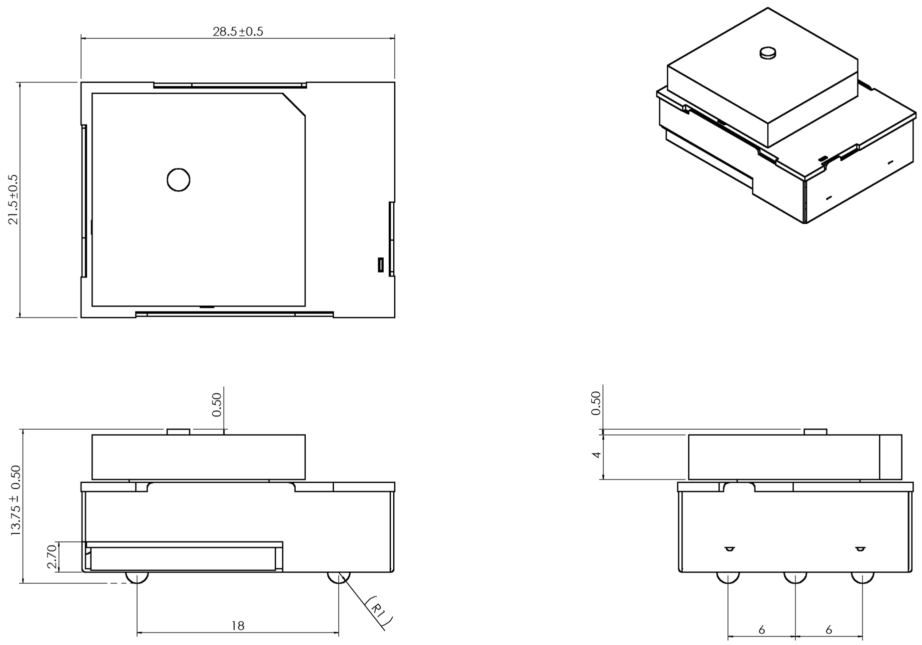
RGM-3000E



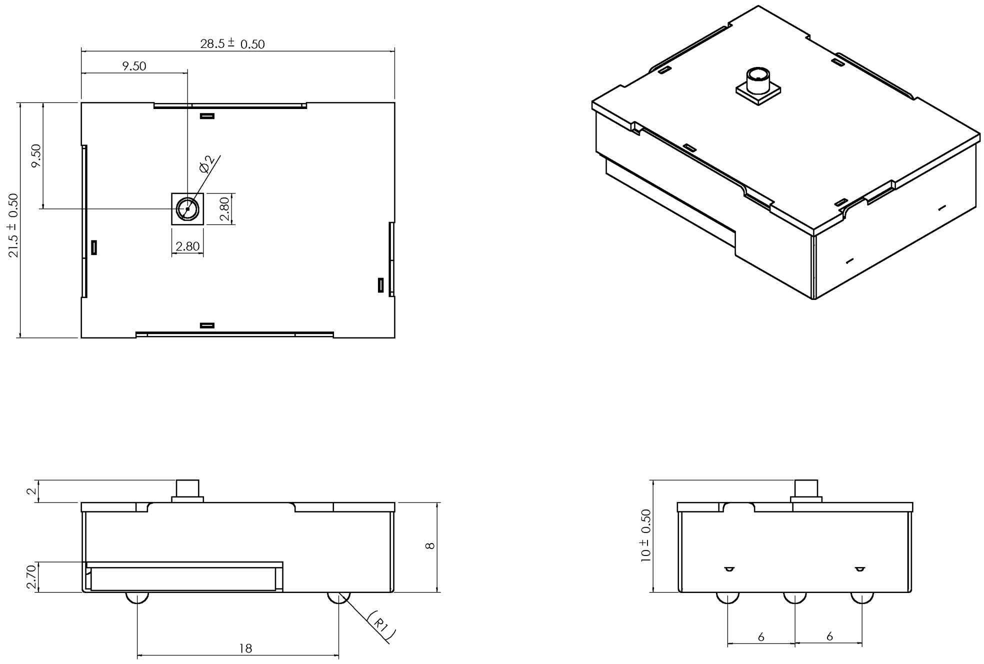
RGM-3000L



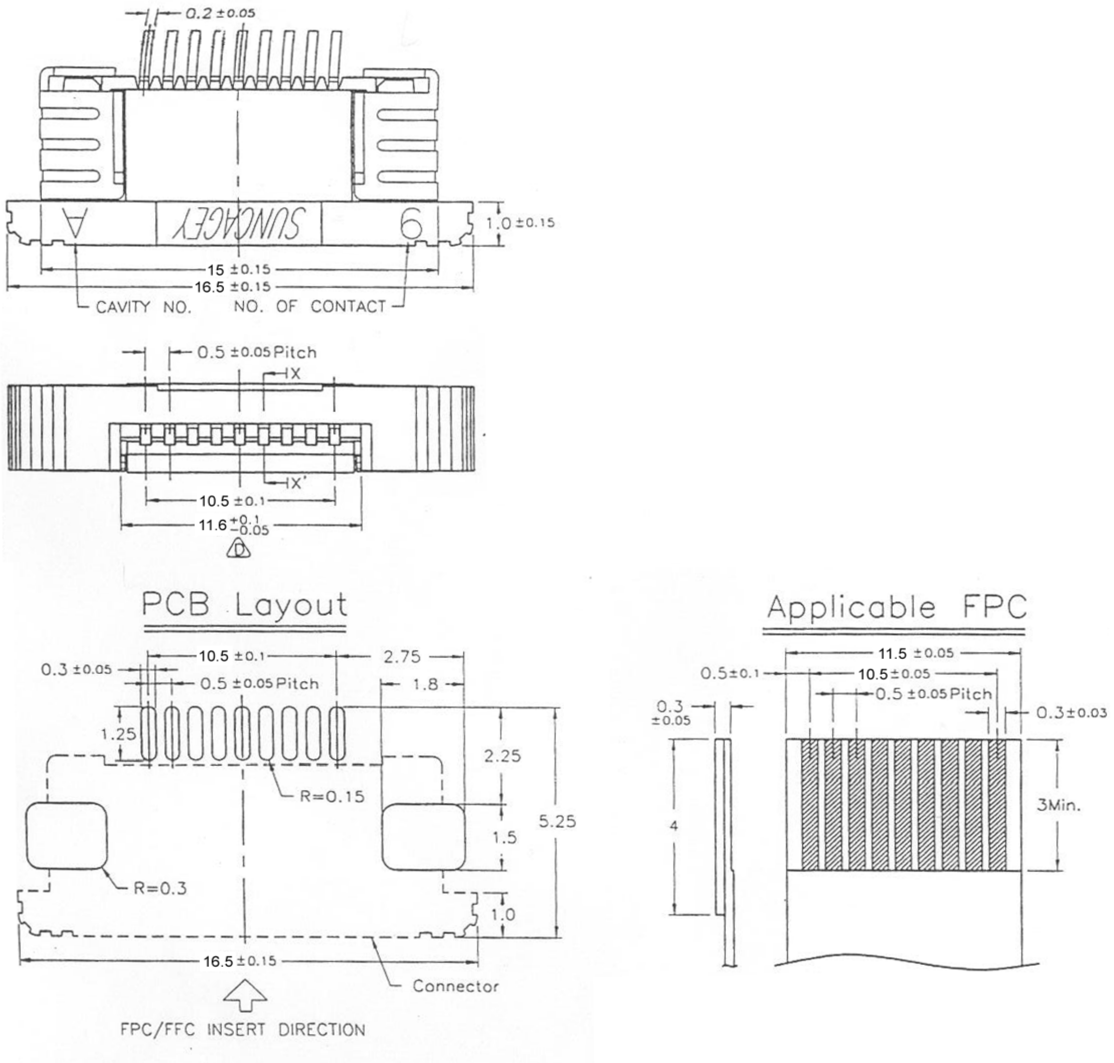
RGM-3000M



REB-3000



Flexible Flat Circuit & Connectot



Hardware interface

RGM-3000/REB-3000.

Pin NO	Name	I/O	Description	Characteristic
1	VCC		System Power	DC 3.3V ± 10%
2	VCC		System Power	DC 3.3V ± 10%
3	TXA	O	Navigation Data Output	TTL Level；Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA
4	RXA	I	Serial Data Input	TTL Level；Vih≧0.7*VCC；Vil≦0.3*VCC
5	TXB	O	Reserved	TTL Level；Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA
6	RXB	I	RTCM 104 Differential GPS Input	TTL Level；Vih≧0.7*VCC；Vil≦0.3*VCC
7	TIMEMARK	O	1 Pulse per second time mark Output	Vil≦0.2V, Pulse Width≧10ms
8	RESET	I	System Reset, Active Low	Vil≦0.2V, Pulse Width≧1ms
9	BOOTSEL	I	Internal boot, Active High	TTL Level；Vih≧0.7*VCC；Vil≦0.3*VCC
10	WAKEUP	I	Active low wakeup from the RTC	TTL Level；Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA
11	VBAT		External Backup Power Input	2.1V≦ Vbat ≦3.6V
12	RESERVED			
13	GPIO3	I/O	General Purpose I/O Pin	TTL Level； Output：Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA Input：Vih≧0.7*VCC；Vil≦0.3*VCC
14	GPIO5	I/O	General Purpose I/O Pin	TTL Level； Output：Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA Input：Vih≧0.7*VCC；Vil≦0.3*VCC
15	GPIO6	I/O	General Purpose I/O Pin	TTL Level； Output：Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA Input：Vih≧0.7*VCC；Vil≦0.3*VCC
16	GPIO7	I/O	General Purpose I/O Pin	TTL Level； Output：Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA Input：Vih≧0.7*VCC；Vil≦0.3*VCC
17	GPIO10	I/O	General Purpose I/O Pin	TTL Level； Output：Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA Input：Vih≧0.7*VCC；Vil≦0.3*VCC
18	GPIO13	I/O	General Purpose I/O Pin	TTL Level； Output：Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA Input：Vih≧0.7*VCC；Vil≦0.3*VCC
19	GPIO15	I/O	General Purpose I/O Pin	TTL Level； Output：Voh≧2.4V, Vol≦0.4V；Ioh=Iol=2mA Input：Vih≧0.7*VCC；Vil≦0.3*VCC
20	GND		System GND	
21	GND		System GND	
22	GND		System GND	

VCC DC Power Input

This is the main power supply for the Engine board. The power range is from 3.3V±10%, ripple ≤ 200mV. The maximum current of RGM-3000 is ≤ 200mA.

GND

GND provides the ground for the Engine board. Connect all grounds.

VBAT

This is the battery backup supply that powers the SRAM and RTC when main power is removed. The input voltage level is from 2.1V~3.6V. Max current draw is 10 uA at 3.3volt. Without an external backup battery or on board battery, engine board will execute a cold start after every turn on. To achieve the faster start-up offered by a hot or warm start, either a backup battery must be connected or battery installed on board.

TXA

This is the main transmit channel and is used to output navigation and measurement data to user written software. The default setup is NMEA Output, 4800bps, 8 data bits, no parity, 1 stop bit. The default sentences are GPGGA, GPGSA, GPRMC once per second and GPGSV once per 5 seconds.

Please refer to “software interface” for the detail protocol.

RXA

This is the main receiving channel and is used to receive software commands to the Engine board from user written software. Please refer to “software interface” for the detail protocol.

RXB

This is used for DGPS differential input .

BOOTSEL

Pull Bootsel pin high & reset , then it will get to boot mode.

GPIO

This pin can be programmed to input or output. For more application, please contact Royaltek’s sales.

Absolute maximum ratings

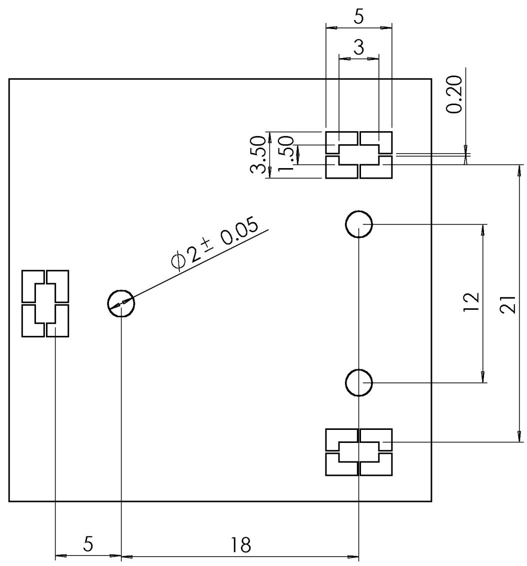
Parameter	Symbol	Unit	Min. Value	Max. Value
Supply voltage	VCC	V	2.97	3.63
Output current		mA		200

Critical design guide and diagram

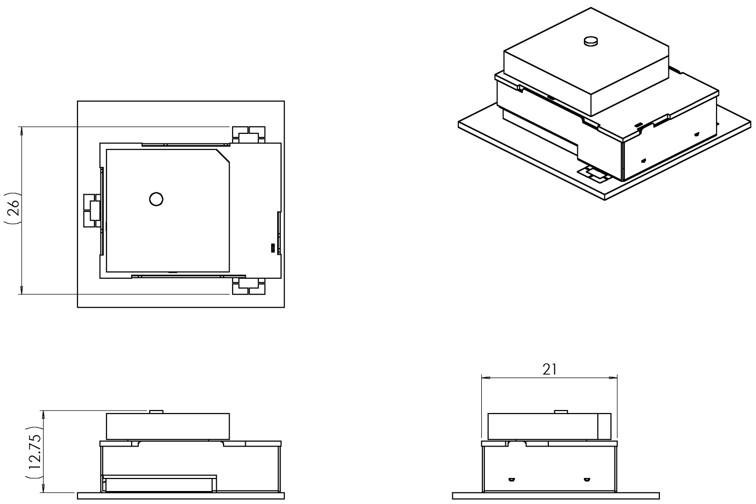
1. It is recommanded to attach GNDu plate (30*30MM) below RGM3000M module or the antenna module of RGM-3000E to increase the intensity of reception . Please refers to “Design Layout Diagram “ .
2. During design of integrated layout, please isolate high frequency noise source (power Switch,data or address signal lines) from GPS antenna.
3. Please don’t place metal object above patch antenna.

Design Layout Diagram

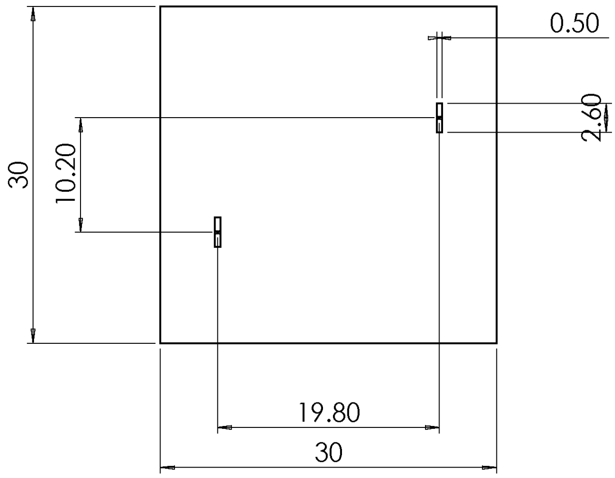
Recommanded Ground plate for RGM-3000M



RGM-3000M with ground plate



Recommanded RGM-3000-A Antenna Ground Plate



Connector tool (Option, not included in standard kit)

It is used to remove or install FPC on connector.

Software interface

NMEA V2.2 Protocol

It is the RS-232 interface:9600 bps, 8 bit data, 1 stop bit and no parity. It supports the following NMEA-0183 messages:GGA, GLL, GSA, GSV, RMC and VTG.

NMEA Output Messages

The Engine board outputs the following messages as shown in Table 1:

Table 1 NMEA-0183 Output Messages

NMEA Record	Description
GGA	Global positioning system fixed data
GLL	Geographic position – latitude / longitude
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed

GGA-Global Positioning System Fixed Data

Table 2 contains the values of the following example: $GPGGA, 161229.487, 3723.2475, N, 12158.3416, W, 1, 07, 1.0, 9.0, M, , , ,0000*18

Table 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Position	161229.487		hhmmss.sss
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table 2-1
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	meters	
Units	M	meters	
Geoid Separation		meters	
Units	M	meters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*18		
＜CR＞＜LF＞			End of message termination

Table 2-1 Position Fix Indicator

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid

GLL-Geographic Position – Latitude/Longitude

Table 3 contains the values of the following example:$GPGLL, 3723.2475, N, 12158.3416, W, 161229.487, A*2C

Table 3 GLL Data Format

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		Dddmm.mmmm
E/W Indicator	W		E=east or W=west
UTC Position	161229.487		hhmmss.ss
Status	A		A=data valid or V=data not valid
Checksum	*2C		
＜CR＞＜LF＞			End of message termination

GSA-GNSS DOP and Active Satellites

Table 4 contains the values of the following example:$GPGSA, A, 3, 07, 02, 26, 27, 09, 04, 15, , , , , , 1.8,1.0,1.5*33

Table 4 GSA Data Format

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 4-2
Mode 2	3		See Table 4-1
Satellite Used	07		Sv on Channel 1
Satellite Used	02		Sv on Channel 2
….			….
Satellite Used			Sv on Channel 12
PDOP	1.8		Position Dilution of Precision
HDOP	1.0		Horizontal Dilution of Precision
VDOP	1.5		Vertical Dilution of Precision
Checksum	*33		
＜CR＞＜LF＞			End of message termination

Table 4-1 Mode 1

Value	Description
1	Fix not available
2	2D
3	3D

Table 4-2 Mode 2

Value	Description
M	Manual-forced to operate in 2D or 3D mode
A	Automatic-allowed to automatically switch 2D/3D

GSV-GNSS Satellites in View

Table 5 contains the values of the following example: $GPGSV, 2, 1, 07, 07, 79, 048, 42, 02, 51, 062, 43, 26, 36, 256, 42, 27, 27, 138, 42*71$GPGSV, 2, 2, 07, 09, 23, 313, 42, 04, 19, 159, 41, 15, 12, 041, 42*41

Table 5 GSV Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Messages[1]	2		Range 1 to 3
Messages Number[1]	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1(Range 1 to 32)
Elevation	79	degrees	Channel 1(Maximum 90)
Azimuth	048	degrees	Channel 1(True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
….			….
Satellite ID	27		Channel 4(Range 1 to 32)
Elevation	27	degrees	Channel 4(Maximum 90)
Azimuth	138	degrees	Channel 4(True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
Checksum	*71		
＜CR＞＜LF＞			End of message termination

[1]Depending on the number of satellites tracked multiple messages of GSV data may be required.

RMC-Recommended Minimum Specific GNSS Data

Table 6 contains the values of the following example: $GPRMC, 161229.487, A, 3723.2475, N, 12158.3416, W, 0.13, 309.62, 120598, ,*10

Table 6 *RMC* Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	knots	
Course Over Ground	309.62	degrees	True
Date	120598		ddmmyy
Magnetic Variation		degrees	E=east or W=west
Checksum	*10		
<CR><LF>			End of message termination

VTG-Course Over Ground and Ground Speed

Table 7 contains the values of the following example:$GPVTG, 309.62, T, , M, 0.13, N, 0.2, K*6E

Table 7 VTG Data Format

Name	Example	Units	Description
Message ID	$GPVTG		VTG protocol header
Course	309.62	degrees	Measured heading
Reference	T		True
Course		degrees	Measured heading
Reference	M		Magnetic
Speed	0.13	knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	km/hr	Measured horizontal speed
Units	K		Kilometer per hour
Checksum	*6E		
<CR><LF>			End of message termination

SiRF Proprietary NMEA Input Messages

NMEA input messages allow you to control the Evaluation Unit in NMEA protocol mode. The Evaluation Unit may be put into NMEA mode by sending the SiRF Binary protocol message " Switch To NMEA Protocol – Message I.D.129 " on page 17 using a user program or using SiRFdemo.exe and selecting Switch to NMEA Protocol from the Action manual. If the receiver is in SiRF Binary mode, all the NMEA input messages are ignored. Once the receiver is put into NMEA mode, the following messages may be used to command the module.

Transport Message

Start Sequence	Payload	Checksum	End Sequence
$PSRF<MID>[1]	Data[2]	*CKSUM[3]	<CR><LF>[4]

[1]Message Identifier consists of three numeric characters . Input messages begin at MID 100.

[2]Message specific data. Refer to a specific

message section for <data>…<data> definition

[3]CKSUM is a two-hex character checksum as defined in the NMEA specification . Use of checksums is required on all input messages.

[4]Each message is terminated by using Carriage Return (CR) Line Feed (LF) which is \r\n which is hex 0D 0A. Because \r\n are not printable ASCII characters , they are omitted from the example strings, but must be sent to terminate the message and cause the receiver to process that input message.

Note – All fields in all proprietary NMEA messages are required, none are exceptional. All NMEA messages are comma delimited

SIRF NMEA Input Messages

Message	Message Identifier (MID)	Description
Set Serial Port	100	Set PORT A Parameters and protocol
Navigation Initialization	101	Parameters required for start using X/Y/Z
Set DGPS Port	102	Set PORT B parameters for DGPS input
Query / Rate Control	103	Query standard NMEA message and/or set output rate
LLA Navigation Initialization	104	Parameters required for start using Lat/Lon/Alt1
Development Data On/Off	105	Development Data messages On/Off

Input coordinates must be WGS84.

Set Serial Port

This command message is used to set the protocol (SiRF Binary or NMEA) and/or the communication parameters (baud , data bits, stop bits, parity). Generally, this command is used to switch the module back to SiRF Binary protocol mode where a more extensive command message set is available. When a valid message is received, the parameters are stored in battery-backed SRAM and then the Evaluation Unit restarts using the saved parameters.

Table 8 contains the input values for the following example:Switch to SIRF Binary protocol at 9600,8,N,1

$PSRF100,0,9600,8,1,0*0C

Table 8 Set Serial Port Data Format

Name	Example	Units	Description
Message ID	$PSRF100		PSRF100 protocol header
Protocol	0		0=SiRF Binary, 1=NMEA
Baud	9600		4800,9600,19200,38400
Data Bits	8		8,7[1]
Stop Bits	1		0,1
Parity	0		0=None ,1=Odd,2=Even
Checksum	*0C		
<CR><LF>			End of message termination

[1]SiRF protocol is only valid for 8data bits, 1 stop bit, and no parity.

LLA Navigation Initialization

This command is used to initialize the module for a warm start, which provide current position (in X, Y, Z coordinates), clock offset , and time .This enables the Evaluation Unit to search for the correct satellite signals at the correct signal parameters . Correct initialization parameters enable the Evaluation Unit to acquire signals quickly.

Table 9 contains the input values for the following example:Switch to SiRF Binary protocol at 9600,8,N,1

$PSRF101,-2686700,-4304200, 3851624, 95000, 497260, 921, 12, 3*22

Table 9 Navigation Initialization Data Format

Name	Example	Units	Description
Message ID	$PSRF101		PSRF101 protocol header
ECEF X	-2686700	Meters	X coordinate position
ECEF Y	-4304200	Meters	Y coordinate position
ECEF Z	3851624	Meters	Z coordinate position
CLK Offset	95000	Hz	Clock Offset of the Evaluation Unit[1]
Time Of Week	497260	seconds	GPS Time OF Week
Week No	921		GPS Week Number
Channel Count	12		Range 1 to 12
Reset Cfh	3		See Table 10
Checksum	*22		
<CR><LF>			End of message termination

Use 0 for last saved value if available . If this is unavailable, a default value of 96,000 will be used…

Table 10 Reset Configuration

Hex	Description
0x01	Data Valid – Warm /Hot Starts=1
0x02	Clear Ephemeris – Warm Start=1
0x04	Clear Memory – Cold Start =1

Set DGPS Port

This command is used to control Serial Port B which is an input – only serial port used to receive RTCM differential corrections. Differential receivers may output corrections using different communication parameters. The default communication parameters for PORT B are 9600 baud, 8 data bits, stop bit, and no parity. If a DGPS received , the parameters are stored in battery – backed SRAM and then the receiver restarts using the saved parameters.

Table 11 contains the input values for the following example:Set DGPS Port to be 9600,8,N,1. $PSRF102,9600,8,1,0*3C

Table 11 Set DGPS Port Data Format

Name	Example	Units	Description
Message ID	$PSRF102		PSRF102 protocol header
Baud	9600		4800,9600,19200,38400
Data Bits	8		8,7
Stop Bits	1		0,1
Parity	0		0==None, 1=Odd, 2=Even
Checksum	*3C		
<CR><LF>			End of message termination

Query/Rate Control

This command is used to control the output of standard NMEA messages GGA, GLL, GSA, RMC, and VTG. Using this command message, standard NMEA messages may be polled once, or setup for periodic output. Checksums may also be enabled or disabled depending on the needs of the receiving program. NMEA message settings are saved in battery-backed memory for each entry when the message is accepted.

Table 12 Query/Rate Control Data Format(See example 1.)

1.Quety the GGA message with checksum enabled: $PSRF103,00,01,00,01*25

2.Enable VTG message for a 1 Hz constant output with checksum enabled: $PSRF103,05,00,01,01*20

3.Disable VTG message $PSRF103,05,00,00,01*21

Table 12 Query/Rate Control Data Format(See example 1.)

Name	Example	Units	Description
Message ID	$PSRF103		PSRF102 protocol header
Message	00		See Table 13
Mode	01		0=Set Rate, 1=Query
Rate	00	seconds	Output – off=0,max=255
Cksum Enable	01		0=Disable Checksum, 1=Enable Checksum
Checksum	*25		
<CR><LF>			End of message termination

Table 13 Messages

Value	Description
0	GGA
1	GLL
2	GSA
3	GSV
4	RMC
5	VTG

LLA Navigation Initialization

This command is used to initialize the module for a warm start , by providing current position(in latitude, longitude, and altitude coordinates), clock offset, and time. This enables the receiver to search for the correct satellite signals at the correct signal parameters . Correct initialization parameters enable the receiver to acquire signals quickly.

Table 14 contains the input values for the following example: Start using known position and time $PSRF104, 37.3875111, -121.97232, 0, 95000, 237759, 922, 12, 3*3A

Table 14 LLA Navigation Initialization Data Format

Name	Example	Units	Description
Message ID	$PSRF104		PSRF104 protocol header
Lat	37.3875111	Degrees	Latitude position (Range 90 to –90)
Lon	-121.97232	Degrees	Longitude position (Range 180 to –180)
Alt	0	Meters	Altitude position
CLK Offset	95000	Hz	Clock Offset of the Evaluation Unit[1]
Time Of Week	237759	Seconds	GPS Time Of Week
Week No	922		GPS Week Number
Channel Count	12		Range 1 to 12
Reset Cfg	3		See Table 15
Checksum	*3A		
<CR><LF>			End of message termination

Use 0 for last saved value if available. If this is unavailable, a default value of 96,000 will be used.

Table 15 Reset Configuration

Hex	Description
0x01	Data Valid – Warm /Hot Starts=1
0x02	Clear Ephemeris – Warm Start=1

0x04	Clear Memory – Cold Start =1

Development Data On/Off

Use this command to enable development data information if you can not get the commands accepted. Invalid commands generate debug information that enables the user to determine the source of the command rejection. Common reasons for input command rejection are invalid checksum of parameter out of specified range.

Table 16 contains the input values for the following examples:

1. Debug On $PSRF105,1*3E
2. Debug Off $PSRF 105,0*3F

Table 16 Development Data On/Off Data Format

Name	Example	Units	Description
Message ID	$PSRF105		PSRF105 protocol header
Debug	1		0=Off , 1= On
Checksum	*3E		
<CR><LF>			End of message termination

Calculating Checksums for NMEA Input

The Checksum is the 8-bit exclusive OR of all the characters after $ and before *. (Not including $ and *)

SiRF Binary Protocol

The serial communication protocol is designed to include:

- Reliable transport of messages
- Ease of implementation
- Efficient implementation
- Independence from payload

Protocol Layers Transport Message

Start Sequence	Payload Length	Payload	Message Checksum	EndSequence
0xA0[1], 0xA2	Two-bytes (15-bits)	Up to 2^{10}-1 (<1023)	Two-bytes (15-bits)	0xB0, 0xB3

0xYY denotes a hexadecimal byte value. 0xA0 equals 160.

Transport

The transport layer of the protocol encapsulates a GPS message in two start characters and two stop characters. The values are chosen to be easily identifiable and such that they are unlikely to occur frequently in the data. In addition, the transport layer prefixes the message with a two-byte (15- bit)message length and a two-byte(15-bit) choice of a 15-bit values for length and check sum are designed such that both message length and check sum can not alias with either the stop of start code.

Message Validation

The validation layer is of part of the transport, but operates independently. The byte count refers to the payload byte length. Likewise, the check sum is a sum on the payload.

Message Length

The message length is transmitted high order byte first followed by the low byte.

High Byte	Low Byte
<0x7F>	Any value

Even though the protocol has a maximum length of (2^{15} -1) bytes practical considerations require the SiRF GPS module implementation to limit this value to a smaller number. Likewise, the SiRF receiving programs (e.g., SiRF demo) may limit the actual size to something less than this maximum..

Payload Data

The payload data follows the message length. It contains the number of bytes specified by the message length. The payload data may contain any 8-bit value. Where multi-byte values are in the payload data neither the alignment nor the byte order are defined as part of the transport although SiRF payloads will use the big-endian order.

Checksum

The check sum is transmitted high order byte first followed byte the low byte. This is the so-called big- endian order

High Byte	Low Byte
<0x7F	Any value

The check sum is 15-bit checksum of the bytes in the payload data .The following pseudo code defines the algorithm used. Let message to be the array of bytes to be sent by the transport. Let msgLen be the number of bytes in the message array to be transmitted .

```
Index = first
checkSum = 0
while index < msgLen
checkSum = checkSum +message[index]
checkSum = checkSum AND(2^15-1)
```

Input Messages for SiRF Binary Protocol

Note – All input messages are sent in BINARY format

Table 19 SiRF Messages – Input Message List

Hex	ASCII	Name
0 x 80	128	Initialize Data Source
0 x 81	129	Switch to NMEA Protocol
0 x 82	130	Set Almanac
0 x 84	132	Software Version
0x 85	133	DGPS Source Control
0x 86	134	Set Main Serial Port
0 x 88	136	Mode Control
0 x 89	137	DOP Mask Control
0 x 8A	138	DGPS Mode
0 x 8B	139	Elevation Mask
0 x 8C	140	Power Mask
0 x 8D	141	Editing Residual
0 x 8E	142	Steady-State Detection
0 x 8F	143	Static Navigation
0 x 90	144	Clock Status
0 x 91	145	Set DGPS Serial Port

0 x 92	146	Almanac
0 x 93	147	Ephemeris
0 x 95	149	Set Ephemeris
0 x 96	150	Switch Operating Mode
0 x 97	151	Set Trickle Power Parameters
0 x 98	152	Navigation Parameters (Poll)
0x A5	165	Change UART Configuration
0x A6	166	Set Message Rate
0x A7	167	Low Power Acquisition Parameters

Initialize Data Source-Message I.D. 128

Table 18 contains the input values for the following example:Warm start the receiver with the following initialization data:ECEF WYZ (-2686727 m,-4304282 m,3851642 m),Clock Offset (75,000 Hz),Time of Week(86,400 s),Week Number(924),Week Number(924),and Channels(12). Raw track data Debug data enabled.

Example:

A0A20019-Start Sequence and Payload Length

80FFD700F9FFBE5266003AC57A000124F80083S600039C0C33- Payload

0A91B0B3-Message Checksum and End Sequence

Table 20 Initialize Data Source

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		80		ASCII 128
ECEF X	4		FFD700F9	meters	
ECEF Y	4		FFBE5266	meters	
ECEF Z	4		003AC57A	meters	
Clock Offset	4		000124F8	Hz	
Time of Week	4	*100	0083D600	seconds	
Week Number	2		039C		
Channels	1		0C		Range 1-12
Reset Config.	1		33		See Table 19

Payload Length: 25 bytes

Table 21 Initialize Data Source

Bit	Description
0	Data valid flag-set warm/hot start
1	Clear ephemeris-set warm start
2	Clear memory-set cold start
3	Factory Reset
4	Enable Nav Lib data (YES=1,NO=0)
5	Enable debug data for SiRF binary protocol(YES=1,NO=0)
6	Enable debug data for NMEA protocol(YES=1,NO=0)
7	Reserved (must be 0)

Note - If Nav Lib data is ENABLED then the resulting messages are enabled. Clock Status (MID 7), 50 BPS (MID 8), Raw DGPS (17), NL Measurement Data (MID 28), GPS Data (MID 29), SV State Data (MID 30), and NL Initialize Data (MID 31). All messages are sent at 1 Hz and the baud rate will be automatically set to 57600.

Switch To NMEA – Message I.D. 129

Table 20 contains the input values for the following example:

Request the following NMEA data at 9600 baud:

GGA – ON at 1 sec , GLL – 0sec , GSA – ON at 5 sec GSV – ON at 5 sec , RMC – 0 sec , VTG – 0 sec

Example:

A0A20018 – Start Sequence and Payload Length

810201010001050105010001000100010001000112C0 – Payload

016AB0B3 – Message Checksum and End Sequence

Table 22 Switch To NMEA Protocol

Name	Bytes	Binary(Hex) Scale	Example	Units	Description
Message ID	1		81		ASCII 129
Mode	1		02		
GGA Message[1]	1		01	1/s	
Checksum[2]	1		01		
GLL Message	1		00	1/s	
Checksum	1		01		
GSA Message	1		05	1/s	
Checksum	1		01		
GSV Message	1		05	1/s	
Checksum	1		01		
RMC Message	1		00	1/s	
Checksum	1		01		
VTG Message	1		00	1/s	
Checksum	1		01		
MSS Message	1		00		Recommended value
Checksum	1		01		Recommended value
Unused Field	1		00		Recommended value
Unused Field	1		01		Recommended value
Unused Field	1		00		Recommended value
Unused Field	1		01		Recommended value
Unused Field	1		00		Recommended value
Unused Field	1		01		Recommended value
Baud Rate	1		12C0		38400,19200,9600,4800,2400

Payload Length: 24bytes

(1) A value of 0x00 implies NOT to send message, otherwise data is sent at 1 message every X seconds requested (i.e., to request a message to be sent every 5 seconds, request the message using a value of 0x05.)Maximum rate is 1/255s.

(2) A value of 0x00 implies the checksum is NOT calculated OR transmitted with the message (not recommended) .A value of 0x01 will have a checksum calculated and transmitted as part of the message (recommended).

Set Almanac- Message I.D. 130

This command enables the user to upload an almanac to the Evaluation Unit

Note – This feature is not documented in this manual. For information on implementation contact SiRF Technology Inc.

Software Version – Message I.D. 132

Table 21 contains the input values for the following example:Poll the software version

Example:

A0A20002 – Start Sequence and Payload Length

8400 – Payload

0084B0B3 – Message Checksum and End Sequence

Table 23 Software Version

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		84		ASCII 132
TBD	1		00		

Payload Length: 2 bytes

DGPS Source – Message I.D. 133

This command allows the user to select the source for DGPS corrections. Options available are:

External RTCM Data (any serial port)

WAAS (subject to WAAS satellite availability)

Internal DGPS beacon receiver

Example 1: Set the DGPS source to External RTCM Data

A0A20007—Start Sequence and Payload Length

85020000000000—Payload

0087B0B3—Checksum and End Sequence

Table B-6 DGPS Source Selection (Example 1)

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		85		Message identifier
DGPS Source	1		00		See Table B-8. DGPS Source Selections
Internal Beacon	4		00000000	Hz	See Table B-9. Internal Beacon Search setting.
Internal Beacon Bit Rate	1		0	BPS	See Table B-9. Internal Beacon Search setting.

Payload: 7Bytes.

Example2: Set the DGPS source to Internal DGPS Beacon Receiver

Search Frequency 310000, Bit Rate 200

A0A20007—Start Sequence and Payload Length

85030004BAF0C802—Payload

02FEB0B3—Checksum and End Sequence

Table B-7 DGPS Source Selection (Example 2)

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		85		Message identifier
DGPS Source	1		03		See Table B-8. DGPS Source Selections
Internal Beacon	4		0004BAF0	Hz	See Table B-9. Internal Beacon Search setting.
Internal Beacon Bit Rate	1		C8	BPS	See Table B-9. Internal Beacon Search setting.

Payload: 7Bytes.

Table B- 8 DGPS Source Selections

DGPS Source	Hex	Decimal	Description
None	00	0	DGPS corrections will not be used (even if available).

WAAS	01	1	Uses WAAS Satellite (subject to availability).
External RTCM Data	02	2	External RTCM input source (i.e., Coast Guard Beacon).
Internal DGPS Beacon Receiver	03	3	Internal DGPS beacon receiver.

Table B- 9 Internal Beacon Search Settings

Search Type	Frequency	Bit Rate	Description
Auto Scan	0	0	Auto scanning of all frequencies and bit rates are performed.
Full Frequency Scan	0	Non zero	Auto scanning of all frequencies and specified bit rate are performed.
Full Bit Rate Scan	Non Zero	0	Auto scanning of all bit rates and specified frequency are performed.
Specific Search	Non Zero	Non Zero	Only the specified frequency and bit rate search are performed.

Set Main Serial Port-Message I.D. 134

Table B-10 contains the input values for the following example:

Set Main Serial port to 9600,n,8,1.

Example:

A0A20009—Start Sequence and Payload Length

860000258008010000—Payload

0134B0B3—Message Checksum and End Sequence

Table B- 10 Set Main Serial Port

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		86		Message identifier
Baud	4		00002580		38400,19200,9600,4800,2400,1200
Data Bits	1		08		8,7
Stop Bit	1		01		0,1
Parity	1		00		None=0, Odd=1, Even=2
Pad	1		00		Reserved

Payload Length: 9 bytes

Mode control – Message I.D .136

Table 24 contains the input values for the following example: 3D Mode = Always , Alt Constraining = Yes , Degraded Mode – clock then direction , TBD = 1 , DR Mode = Yes , Altitude = 0, Alt Hold Mode = Auto, Alt Source = Last Computed , Coast Time Out = 20, Degraded Time Out = 5, DR Time Out = 2, Track Smoothing = Yes

Example:

A0A2000W – Start Sequence and Payload Length

8801010101010000000002140501 – Payload

00A9B0B3 – Message Checksum and End Sequence

Table 24 Mode Control

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		88		ASCII 136
3D Mode	1		01		1 (always true=1)
Alt Constraint	1		01		YES = 1,NO = 0
Degraded Mode	1		01		See Table C-7
TBD	1		01		Reserved
DR Mode	1		01		YES = 1,NO = 0
Altitude	2		0000	Meters	Range –1,000 to 10,000
Alt Hold Mode	1		00		Auto = 0,Always=1,Disable=2
Alt Source	1		02		Last Computed=0,Fixed to=1
Coast Time Out	1		14	Seconds	0 to 120
Degraded Time Out	1		05	Seconds	0 to 120
Dr Time Out	1		01	Seconds	0 to 120
Track Smoothing	1		01		YES = 1,NO = 0

Payload Length:14 bytes

Table 25 Degraded Mode Byte Value

Byte Value	Description
0	Use Direction then Clock Hold
1	Use Clock then Direction Hold
2	Direction(Curb)Hold Only
3	Clock(Time)Hold Only
4	Disable Degraded Modes

DOP Mask Control – Message I.D. 137

Table 26 contains the input values for the following example:

Auto Pdop/Hdop, Gdop = 8(default),Pdop=8,Hdop=8

Example:

A0A20005 – Start Sequence and Payload Length

8900080808 – Payload

00A1B0B3 – Message Checksum and End Sequence

Table 26 DOP Mask Control

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		88		ASCII 137
DOP Selection	1		00		See Table 25
GDOP Value	1		08		Range 1 to 50
PDOP Value	1		08		Range 1 to 50
HDOP Value	1		08		Range 1 to 50

Payload Length: 5 bytes

Table 27 DOP Selection

Byte Value	Description
0	Auto PDOP/HDOP
1	PDOP
2	HDOP
3	GDOP
4	Do Not Use

DGPS Control – Message I.D.138

Table 28 contains the input values for the following example:

Set DGPS to exclusive with a time out of 30 seconds.

Example:

A0A20003 – Start Sequence and Payload Length

8A011E – Payload

00A9B0B3 – Message Checksum and End Sequence

Table 28 DGPS Control

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		8A		ASCII 138
DGPS Selection	1		01		See Table 27
DGPS Time Out	1		1E	Seconds	Range 1 to 120

Payload Length:3 bytes

Table 29 DGPS Selection

Byte Value	Description
0	Auto
1	Exclusive
2	Never
3	Mixed (not recommended)

Elevation Mask – Message I.D.139

Table 30 contains the input values for the following example:

Set Navigation Mask to 15.5 degrees (Tracking Mask is defaulted to 5 degrees).

Example:

A0A20005 – Start Sequence and Payload Length

8B0032009B – Payload

0269B0B3 – Message Checksum and End Sequence

Table 30 Elevation Mask

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		8B		ASCII 139
Tracking Mask	2	*10	0032	degrees	Not currently used
Navigation Mask	2	*10	009B	degrees	Range –20.0 to 90.0

Payload Length:5 bytes

Power Mask – Message I.D.140

Table 31 contains the input values for the following example: Navigation mask to 33dBHz (tracking default value of 28)

Example:

A0A20003 – Start Sequence and Payload Length

8C1C21 – Payload

00C9B0B3 – Message Checksum and End Sequence

Table 31 Power Mask

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		8C		ASCII 140
Tracking Mask	1		1C	dBHz	Not currently implemented
Navigation Mask	1		21	dBHz	Range –28 to 50

Payload Length:3 bytes

Editing Residual – Message I.D.141

Note – Not implemented currently

Steady State Detection – Message I.D.142

Table 32 contains the input values for the following example: Set Stead State Threshold to 1.5 m/sec^2

Example:

A0A20002 – Start Sequence and Payload Length

8E0F – Payload

009DB0B3 – Message Checksum and End Sequence

Table 32 Steady Detection

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		8E		ASCII 142
Threshold	1		0F	M /sec2	Range 0 to 20

Payload: 2 bytes

Static Navigation – Message I.D.144

Table 33 Steady State Detection

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		90		ASCII 144
TBD	1		00		Reserved

Payload Length:2 bytes

Set DGPS Serial Port – Message I.D 145

Table 34 contains the input values for the following example:Set DGPS Serial port to 9600.n,8,1.

Example:

A0A20009-Start Sequence and Payload Length

910000258008010000 – Payload

013FB0B3 – Message Checksum and End Sequence

Table 34 Set DGPS Serial Port

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		91		ASCII 145
Baud	4		00002580		38400,19200,9600,4800,2400, 1200
Data Bits	1		08		8,7
Stop Bit	1		01		0,1
Parity	1		00		None=0,Odd=1,Even=2
Pad	1		00		Reserved

Payload Length: 9 bytes

Almanac – Message I.D.146

Table 35 contains the input values for the following example:Poll for the Almanac.

Example:

A0A20002 – Start Sequence and Payload Length

9200 – Payload

0092B0B3 – Message Checksum and End Sequence

Table 35 Almanac

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		92		ASCII 146
TBD	1		00		Reserved

Payload Length: 2 bytes

Ephemeris Message I.D.147

Table 36 contains the input values for the following example:Poll for *Ephemeris* Data for all satellites.

Example:

A0A20003 – Start Sequence and Payload Length

930000 – Payload

0092B0B3 – Message Checksum and End Sequence

Table 36 Almanac

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		93		ASCII 147
Sv I.D.1	1		00		Range 0 to 32
TBD	1		00		Reserved

Payload Length:3 bytes

A value of 0 requests all available ephemeris records, otherwise the ephemeris of the Sv I.D. is requested.

Switch To SiRF Protocol

Note – To switch to SiRF protocol you must send a SiRF NMEA message to revert to SiRF binary mode. (See page 9, " NMEA Input Messages " for more information)

Switch Operating Modes - Message I.D. 150

Table 37 contains the input values for the following example:

Sets the receiver to track a single satellite on all channels.

Example:

A0A20007—Start Sequence and Payload Length

961E510006001E—Payload

0129B0B3—Message Checksum and End Sequence

Table 37 Switch Operating Mode I.D. 150

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		96		ASCII 150
Mode	2		1E51		1E51=test, 0=nomal
SvID	2		0006		Satellite to Track
Period	2		001E	seconds	Duration of Track

Payload length: 7 bytes

Set Trickle Power Parameters - Message I.D. 151

Table 38 contains the input values for the following example: Sets the receiver into low power Modes. Example: Set receiver into Trickle Power at 1 hz update and 200 ms On Time.

A0A20009—Start Sequence and Payload Length

97000000C8000000C8—Payload

0227B0B3—Message Checksum and End Sequence

Table 38 Set Trickle Power Parameters I.D. 151

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		97		ASCII 151
Push To FixMode	2		0000		ON=1, OFF=0
Duty Cycle	2	*10	00C8	%	% Time on
Milli Seconds On Time	4		000000C8	ms	Range 200 ~ 500 ms

Payload Length: 9bytes.

Computation of Duty Cycle and On Time.

The Duty Cycle is the desired time to be spent tracking.The On Time is the duration of each tracking period (range is 200 - 900 ms). To calculate the TricklePower update rate as a function of Duty cycle and On Time, use the following formula:

Off Time = (On Time - (Duty Cycle * On Time)) / Duty Cycle

Update rate = Off Time + On Time

Note – On Time inputs of > 900 ms will default to 1000 ms

Following are some examples of selections:

Table 39 Example of selections for Trickle Power Mode of Operation

Mode	On Time (ms)	Duty Cycle (%)	Update rate (1/Hz)
Continuous	1000	100	1
Trickle Power	200	20	1
Trickle Power	200	10	2
Trickle Power	300	10	3
Trickle power	500	5	10

See Table 40 for supported/unsupported settings.

Table 40 Trickle Power Mode Settings

On Time (ms)	Update Rate (second)							
	1	2	3	4	5	6	7	8
200	Y	Y	N	N	N	N	N	N
300	Y	Y	Y	Y	Y	Y	N	N
400	Y	Y	Y	Y	Y	Y	Y	Y
500	Y	Y	Y	Y	Y	Y	Y	Y
600	Y	Y	Y	Y	Y	Y	Y	Y
700	Y	Y	Y	Y	Y	Y	Y	Y
800	Y	Y	Y	Y	Y	Y	Y	Y
900	Y	Y	Y	Y	Y	Y	Y	Y

Y = Yes (Mode supported)

N = No (Mode NOT supported)

Push-to-Fix

In this mode the receiver will turn on every 30 minutes to perform a system update consisting of a RTC calibration and satellite ephemeris data collection if required (i.e., a new satellite has become visible) as well as all software tasks to support SnapStart in the event of an NMI. Ephemeris collection time in general this takes 18 to 30 seconds. If ephemeris data is not required then the system will re-calibrate and shut down. In either case, the amount of time the receiver remains off will be in proportion to how long it stayed on:

Off period = (On Period*(1-Duty Cycle) / Duty Cycle)

Off Period is limited to 30 minutes. The duty cycle will not be less than approximately On Period/1800, or about 1%. Push-to-Fix keeps the ephemeris for all visible satellites up to date so position/velocity fixes can generally be computed within SnapStart times (when requested by the user) on the order of 3 seconds.

Poll Navigation Parameters - Message I.D. 152

Table C-20 contains the input values for the following example:

Example: Poll receiver for current navigation parameters.

A0A20002—Start Sequence and Payload Length

9800—Payload

0098B0B3—Message Checksum and End Sequence

Table C-20 Poll Receiver for Navigation Parameters

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		98		ASCII 152
Reserved	1		00		

Payload length: 2 bytes

Set UART Configuration - Message I.D. 165

Table B-28 contains the input values for the following example:

Example: Set port 0 to NMEA with 9600 baud, 8 data bits, 1 stop bit, no parity. Set port 1 to SiRF binary with 57600 baud, 8 data bits, 1 stop bit, no parity. Do not configure ports 2 and 3.

Example:

A0A20031—Start Sequence and Payload Length

A50001010000258008010000000100000000E1000801000000FF0505000000000000000000000FF0505000000000000000000000—Payload

0452B0B3—Message Checksum and End Sequence

Table B- 28 Set UART Configuration

Name	Bytes	Binary(Hex)		Units	Description
		Scale	Example		
Message ID	1		A5		Decimal 165
Port	1		00		For UART 0
In Protocol[1]	1		01		For UART 0
Out Protocol	1		01		For UART 0 (Set to In protocol)
Baud Rate[2]	4		00002580		For UART 0
Data bits[3]	1		08		For UART 0
Stop bits[4]	1		01		For UART 0
Parity[5]	1		00		For UART 0
Reserved	1		00		For UART 0
Reserved	1		00		For UART 0
Port	1		00		For UART 1
In Protocol	1		01		For UART 1
Out Protocol	1		01		For UART 1
Baud Rate	4		0000E100		For UART 1
Data bits	1		08		For UART 1
Stop bits	1		01		For UART 1
Parity	1		00		For UART 1
Reserved	1		00		For UART 1
Reserved	1		00		For UART 1
Port	1		00		For UART 1
In Protocol	1		01		For UART 2
Out Protocol	1		01		For UART 2
Baud Rate	4		00000000		For UART 2
Data bits	1		08		For UART 2
Stop bits	1		01		For UART 2
Parity	1		00		For UART 2
Reserved	1		00		For UART 2
Reserved	1		00		For UART 2
Port	1		00		For UART 3
In Protocol	1		01		For UART 3
Out Protocol	1		01		For UART 3
Baud Rate	4		00000000		For UART 3
Data bits	1		08		For UART 3
Stop bits	1		01		For UART 3
Parity	1		00		For UART 3
Reserved	1		00		For UART 3
Reserved	1		00		For UART 3

Payload Length: 49 bytes

1. 0 = SiRF Binary, 1 = NMEA, 2 = ASCII, 3 = RTCM, 4 = User1, 5 = No Protocol.

2. Valid values are 1200, 2400, 4800, 9600, 19200, 38400, and 57600.

3. Valid values are 7 and 8.

4. Valid values are 1 and 2.

5. 0 = None, 1 = Odd, 2 = Even.

Set Message Rate - Message I.D. 166

Table B-29 contains the input values for the following example:

Set message ID 2 to output every 5 seconds starting immediately.

Example:

A0A20008—Start Sequence and Payload Length

A601020500000000—Payload

00AEB0B3—Message Checksum and End Sequence

Table B- 29 Set Message Rate

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		A6		Decimal 166
Send Now[1]	1		01		Poll message
MID to set	1		02		
Update Rate	1		05	sec	Range= 1 - 30
TBD	1		00		Reserved
TBD	1		00		Reserved
TBD	1		00		Reserved
TBD	1		00		Reserved

Payload Length: 8 bytes

1. 0 = No, 1 = Yes, if no update rate the message will be polled.

Low Power Acquisition Parameters - Message I.D. 167

Table B-30 contains the input values for the following example:

Set maximum off and search times for re-acquisition while receiver is in low power.

Example:

A0A20019—Start Sequence and Payload Length

A7000075300001D4C000000000000000000000000000000000—Payload

02E1B0B3—Message Checksum and End Sequence

Table B- 30 Set Low Power Acquisition Parameters

Name	Bytes	Binary(Hex) Scale	Binary(Hex) Example	Units	Description
Message ID	1		A7		Decimal 167
Max Off Time	4		00007530	ms	Maximum time for sleep mode
Max Search Time	4		0001D4C0	ms	Max. satellite search time
TBD	4		00000000		Reserved
TBD	4		00000000		Reserved
TBD	4		00000000		Reserved
TBD	4		00000000		Reserved

Payload Length: 25 bytes

Output Messages for SiRF Binary Protocol

Note – All output messages are received in BINARY format. SiRF demo interprets the binary data and saves if to the log file in ASCII format.

Table 42 lists the message list for the SiRF output messages

Hex	ASCII	Name	Description
0x02	2	Measured Navigation Data	Position, velocity, and time
0x04	4	Measured Tracking Data	Signal to noise information
0x05	5	Raw Track Data	Measurement information
0x06	6	SW version	Receiver software
0x07	7	Clock Status	
0x08	8	50 BPS Subframe Date	Standard ICD format

0x09	9	Throughput	CPU load
0x0B	11	Command Acknowledgment	Successful request
0x0C	12	Command N Acknowledgment	Unsuccessful request
0X0D	13	Visible List	Auto Output
0x0E	14	Almanac Data	
0x0F	15	Ephemeris Data	
0x11	17	Differential Corrections	Received from DGPS broadcast
0x12	18	OkToSend	CPU ON / OFF (Trickle Power)
0x13	19	Navigation Parameters	Response to Poll
0x1C	28	Nav. Lib. Measurement Data	Measurement Data
0x1D	29	Nav. Lib. DGPS Data	Differential GPS Data
0x1E	30	Nav. Lib. SV State Data	Satellite State Data
0x1F	31	Nav. Lib. Initialization Data	Initialization Data
0x64	100	RoyalTek Navigation Data	UTC , lat , lon, validate output
0xFF	255	Development Data	Various data messages

Measure Navigation Data Out –

Message I.D.2

Output Rate: 1 Hz

Table 43 lists the binary and ASCII message data format for the measured navigation data

Example:

A0A20029 – Start Sequence and Payload Length

02FFD6F78CFFBE869E003AC004000301
04A00036B039780E3
0612190E160F04000000000000 –
Payload

09BBB0B3 – Message Checksum, and End Sequence

Table 43 Measured Navigation Data Out – Binary & ASCII Message Data Format

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		02			2
X – position	4		FFD6F78C	M		-2689140
Y – position	4		FFBE536E	M		-4304018
Z – position	4		003AC004	M		3850244
X – velocity	2	*8	00	M/s	Vx/8	0
Y – velocity	2	*8	03	M/s	Vy/8	0.375
Z – velocity	2	*8	01	M/s	/8	0.125
Mode[1]	1		04	Bitmap1		4
DOP[2]	1	*5	A		/5	2.0
Mode[3]	1		00	Bitmap3		0
GPS Week	2		036B			875
GPS TOW	4	*100	039780E3	seconds	/100	602605.79
SVs in Fix	1		06			6
CH 1	1		12			18
CH 2	1		19			25
CH 3	1		0E			14
CH 4	1		16			22
CH 5	1		0F			15
CH 6	1		04			4
CH 7	1		00			0
CH 8	1		00			0
CH 9	1		00			0
CH 10	1		00			0

CH 11	1		00			0
CH 12	1		00			0

Payload Length :41 bytes

[1]For further information , go to *Table 42*

[2]Dilution of precision (DOP) field contains value of PDOP when Position is obtained using 3D solution and HDOP in all other cases.

[3]For further information , go to *Table 43*

Note – Binary units scaled to integer values need to be divided by the scale value to receive true decimal value (i.e., decimal Xvel = binary Xvel /8).

Table 44 Mode 1

Mode 1		Description
Hex	ASCII	
0x00	0	No Navigation Solution
0x01	1	1 Satellite Solution
0x02	2	2 Satellite Solution
0x03	3	3 Satellite Solution (2D)
0x04	4	>=4 Satellite Solution (3D)
0x05	5	2D Point Solution(Krause)
0x06	6	3D Point Solution(Krause)
0x07	7	Dead Reckoning (Time Out)

Table 45 Mode 2

Mode 2		Description
Hex	ASCII	
0x00	0	DR Sensor Data
0x01	1	Validated / Unvalidated
0x02	2	Dead Reckoning (Time Out)
0x03	3	Output Edited by UI
0x04	4	Reserved
0x05	5	Reserved
0x06	6	Reserved
0x07	7	Reserved

Measured Tracker Data Out – Message I.D.4

Output Rate: 1 Hz

Table 46 lists the binary and ASCII message data format for the measured tracker data.

Example:A0A200BC – Start Sequence and Payload Length

04036C0000937F0C0EAB46003F1A1E1D1D191D1A1A1D1F1D59423

F1A1A…. – Payload ****B0B3 – Message Checksum and End Sequence

Table 46 Measured Tracker Data Out

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		04	None		4
GPS Week	2		036C			876
GPS TOW	4	S*100	0000937F	S	S/100	37759

Channels	1		0C			12
1st Sv ID	1		0E			14
Azimuth	1	Az*[2/3]	AB	Degree	/[2/3]	256.5
Elev.	1	El*2	46	Degree	/2	35
State	2		003F	Bitmap1		63
C/NO 1	1		1A			26
C/NO 2	1		1E			30
C/NO 3	1		1D			29
C/NO 4	1		1D			29
C/NO 5	1		19			25
C/NO 6	1		1D			29
C/NO 7	1		1A			26
C/NO 8	1		1A			26
C/NO 9	1		1D			29
C/NO 10	1		1F			31
2nd Sv ID	1		1D			29
Azimuth	1	Az*[2/3]	59	Degree	/[2/3]	89
Elev.	1	El*2	42	Degree	/2	66
State	2		3F	Bitmap1		63
C/NO 1	1		1A			26
C/NO 2	1		1A			63
…..						

Payload Length: 188 bytes

For further information, go to *Table 45*.

Note – Message length is fixed to 188 bytes with non tracking channels reporting zero values

Table 47 Trk. to NAV Struct. Trk._status Field Definition

Field Definition	Hex Value	Description
ACQ_SUCCESS	0x0001	Set if acq/reacq if done successfully
DELTA_CARPHASE_VALID	0x0002	Integrated carrier phase is valid
BIT_SYNC_DONE	0x0004	Bit sync completed flag
SUBFRAME_SYNC_DONE	0x0008	Subframe sync has been done
CARRIER_PULLIN_DONE	0x0010	Carrier pull in done
CODE_LOCKED	0x0020	Code locked
ACQ_FAILED	0x0040	Failed to acquire S/V
GOT_EPHEMERIS	0x0080	Ephemeris data available

Note – When a channel is fully locked and all data is valid , the status shown is 0xBF

Raw Tracker Data Out – Message I.D.5

Output Rate:1 Hz

Table 48 lists the binary and ASCII message data format for the raw tracker data .

Example:

A0A20033 – Start Sequence and Payload Length

05000000070013003F00EA1BD4000D03
9200009783000DF45E000105B5FF90F5
C20000242827272327242427290500000
0070013003F – Payload

0B2DB0B3 – Message Checksum and End Sequence

Table 48 Raw Tracker Data Out

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		05			5
Channel	4		00000007			7
SVID	2		0013			19
State	2		003F	Bitmap[1]		63

Bits	4		00EA1BD4	Bit		15342548
Ms	2		000D	Ms		13
Chips	2		0392	Chip		914
Code Phase	4	2^{-16}	00009783	Chip	$/2^{-16}$	38787
Carrier Doppler	4	2^{-10}	000DF45E	Rad/2ms	$/2^{-10}$	914526
Time Tag	4		000105B5	Ms		66997
Delta Carrier[2]	4	2^{-10}	FF90F5C2	Cycles	$/2^{-10}$	-7277118
Search Count	2		0000			0
C/NO 1	1		24	dBHz		36
C/NO 2	1		28	dBHz		40
C/NO 3	1		27	dBHz		39
C/NO 4	1		27	dBHz		39
C/NO 5	1		23	dBHz		35
C/NO 6	1		27	dBHz		39
C/NO 7	1		24	dBHz		36
C/NO 8	1		24	dBHz		36
C/NO 9	1		27	dBHz		39
C/NO 10	1		29	dBHz		41
Power Loss Count	1		05			5
Phase Loss Count	1		00000007			7
Integration Interval	2		0013	Ms		19
Track Loop Iteration	2		003F			63

Payload Length:51 bytes per satellite tracked (up to 12)

1.For further information,go to Table 45

2.Multiply by $(1000 \div 4\pi) \div 2^{16}$ to convert to Hz.

The meaning of I.D.5 is described as following table

Message ID:	Each SiRF binary message is defined based on the ID.
Channel:	Receiver channel where data was measured (range 1-12).
SVID:	PRN number of the satellite on current channel.
State:	Current channel tracking state (see Table 45)
Bit Number:	Number of GPS bits transmitted since Sat-Sun midnight (in Greenwich) at a 50 bps rate.
Millisecond Number:	Number of milliseconds of elapsed time since the last received bit(20 ms between bits)
Chip Number:	Current C/A code symbol being transmitted (range 0 to 1023 chips;1023 chips=1 ms).
Code Phase:	Fractional chip of the C/A code symbol at the time of sampling(scaled by 2^{-16} ,=1/65536)
Carrier Doppler:	The current value of the carrier frequency as maintained by the tracking loops.
Receiver Time Tag:	This is the count of the millisecond interrupts from the start of the receiver (power on) until the measurement sample is taken. The ms interrupts are generated by the receiver clock.
Delta Carrier Phase:	The difference between the carrier phase(current) and the carrier phase(previous). Units are in carrier cycles with the LSB= 0.00185 carrier cycles. The delta time for the accumulation must be known. Note –Carrier phase measurements are not necessarily in sync with code phase measurement for each measurement epoch.
Search Count:	This is the number of times the tracking software has completed full satellite signal searche.s
C/No:	Ten measurements of carrier to noise ratio(C/No) values in dBHZ at input to the receiver.Each value represents 100 ms of tracker data and its sampling time is not necessarily in sync with the code phase measurement.
Power Loss Count:	The number of times the power detectors fell below the threshold between the present code phase sample and the previous code phase sample. This task is performed every 20 ms (max count is 50).

Phase Loss Count:	The number of time the phase lock fell below the threshold between the present code phase sample and the previous code phase sample. This task is performed every 20 ms (max count is 50).
Integration Interval:	The time in ms for carrier phase accumulation . This is the time difference (as calculated by the user clock) between the Carrier Phase(current) and the Carrier Phase(previous).
Track Loop Iteration:	The tracking Loops are run at 2 ms and 10 ms intervals. Extrapolation values for each interval is 1 ms and 5 ms for range computations.

Calculation of Pseudo-Range Measurements

The pseudo-range measurement in meters can be determined from the raw track data by solving the following equation:

Pseudo-range (PR) = {Received Tine (RT) – Transmit Time (TT)} * C

where C = speed of light

The following variables from the raw track data are required for each satellite:

Bit Number (BN) – 50 bits per second
Millisecond Number (MSN)
Chip Number (CN)
Code Phase (CP)
Receiver Time Tag (RTTag)
Delta Carrier Phase (DCP)

The following steps are taken to get the psr data and carrier data for each measurement epoch.

1. Computation of initial Receiver Time(RT) in seconds. Note-Where the initial arbitrary value chosen at start up to make the PR reasonable (i.e.,set equal to TT+70ms) and then incriminated by one second for each measurement epoch.
2. Computation of Transmit Time (TT) in seconds.
3. Calculate Pseudo-range at a common receiver time of the first channel of the measurement data set. Note-All channel measurements are NOT taken at the same time. Therefore, all ranges must be extrapolated to a common measurement epoch. For simplicity, the first channel of each measurement set is used as the reference to which all other measurements are extrapolated.
4. Extrapolate the pseudo-range based on the correlation interval to improve precision.
5. Compute the delta range.

If the accumulation time of the Dalta Carrier Phase is 1000 ms then the measurement is valid and can be added to the previous Delta Carrier Phase to get Accumulated Carrier Phase data. If the accumulation time of the Delta Carrier Phase is not equal to 1000 ms then the measurement is not valid and the accumulation time must be restarted to get Accumulated Carrier Phase data.

Response :Software Version String – Message I.D.6

Output Rate:Response to polling message

Example:

A0A20015 – Start Sequence and Payload Length

0606312E322E30444B495431313920534D0000000000-Payload

0382B0B3 – Message Checksum and End Sequence

Table 49 Software Tracker Data Out

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		06			6
Character	20		1			2

Payload Length: 21 bytes

Note – Convert to symbol to assemble message (i.e., 0x4E is 'N'). These are low priority task and are not necessarily output at constant intervals.

Response :Clock Status Data – Message I.D.7

Output Rate:1Hz or response to polling message

Example:

A0A20014 – Start Sequence and Payload Length

0703BD021549240822317923DAEF – Payload

0598B0B3 – Message Checksum and End Sequence

Table 50 Clock Status Data Message

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		07			7
GPS Week	2		03BD			957
GPS TOW	4	*100	02154924	S	/100	349494.12
Svs	1		08			8
Clock Drift	4		2231	Hz		74289
Clock Bias	4		7923	ns		128743715
Estimated GPS Time	4		DAEF	ms		349493999

Payload Length:20 bytes

50BPS Data – Message I.D.8

Output Rate:As available (12.5 minute download time)

Example:A0A2002B – Start Sequence and Payload Length

08******** - Payload

****B0B3 – Message Checksum and End Sequence

Table 51 Clock Status Data Message

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		08			8
Channel	1					
Sv ID	1					
Word [10]	40					

Payload Length:43 bytes per subframe (6subframes per page, 25 pages Almanac)

Note – Data is logged in ICD format

(available from www.navcen.uscg.mail)

CPU Throughput – Message I.D.9

Output Rate:1 Hz

Example:A0A20009 – Start Sequence and Payload Length

09003B0011001601E5 – Payload

0151B0B3 – Message Checksum and End Sequence

Table 52 CPU Throughput

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		09			9
SegStatMax	2	*186	003B	ms	/186	.3172
SegStatLat	2	*186	0011	ms	/186	.0914
AveTrkTime	2	*186	0016	ms	/186	.1183
Last MS	2		01E5	ms		485

Payload Length: 9 bytes

Command Acknowledgment – Message I.D.11

Output Rate: Response to successful input message

This is successful almanac (message ID 0x92)request example:

A0A20002 – Start Sequence and Payload Length

0B92 – Payload

009DB0B3 – Message Checksum and End Sequence

Table 53 Command Acknowledgment

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0B			11
Ack.I.D.	1		92			146

Payload Length: 2 bytes

Command N Acknowledgment – Message I.D. 12

Output Rate: Response to rejected Input message

This is unsuccessful almanac (message ID 0x92) request example:

A0A20002 – Start Sequence and Payload Length

0C92 – Payload

009EB0B3 – Message Checksum and End Sequence

Table 54 Command N Acknowledgment

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0C			12
N Ack. I.D	1		92			146

Payload Length:2 bytes

Visible List – Message I.D.13

Output Rate:Updated approximately every 2minutes. Note – This is a variable length message. Only the number of visible satellites are reported(as define by visible Svs in Table 55), Maximum is 12 satellites

Example:A0A2002A – Start Sequence and Payload Length

0D08070029003809013300 2C************

****** - Payload

****B0B3 – Message Checksum and End Sequence

Table 55 Visible List

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0D			13
Visible Svs	1		08			8
CH 1 –Sv I.D	1		07			7
CH 1 –Sv Azimuth	2		0029	Degrees		41
CH 1 –Sv Elevation	2		0038	Degrees		56
CH 2 –Sv I.D	1		09			9
CH 2 –Sv Azimuth	2		0133	Degrees		307
CH 2 –Sv Elevation	2		002C	Degrees		44
……						

Payload Length:62 bytes(maximum)

Almanac Data – Message I.D.14

Output Rate:Response to poll

Example :A0A203A1 – Start Sequence and Payload Length

0E01************* - Payload

****B0B3 – Message checksum and End Sequence

Table 56 Visible List

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0E			14
Sv I.D.(1)	1		01			1
Almanac Data[14][2]	28					
….						
Sv I.D.(32)	1		20			32
Almanac Data[14][2]	28					

Payload Length: 929 bytes(maximum)

OkToSend - Message I.D. 18

Output Rate: Trickle Power CPU on/off indicator

Example:

A0A20002—Start Sequence and Payload Length

1200—Payload

0012B0B3—Message Checksum and End Sequence

Table B- 52 Almanac Data

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		12			18
Send indicator[1]	1		00			00

Payload Length: 2 bytes

1. 0 implies that CPU is about to go OFF, OkToSend==NO, 1 implies CPU has just come ON, OkToSend==YES

Navigation Parameters (Response to Poll) – Message I.D. 19

Output Rate:1 Response to Poll

Example:

A0A20018—Start Sequence and Payload Length

130100000000011E3C0104001E004B1E00000500016400C8—Payload

022DB0B3—Message Checksum and End Sequence

Table B- 53 Navigation Parameters

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		13			19
Reserved	4		00000000			
Altitude Hold Mode	1		00			0
Altitude Hold Source	1		00			0
Altitude Input Source	2		0000	meters		0
Degraded Mode[1]	1		01			1
Degraded Timeout	1		1E	seconds		30
DR Timeout	1		3C	seconds		60
Track Smooth Mode	1		01			1
Static Navigation	1					
3SV Least Squares	1					
Reserved	4					
DOP MASK Mode[2]	1		04			4
Navigation Elevation Mask	2					
Navigation Power Mask	1					
Reserved	4					
DGPS Source	1					
DGPS Mode[3]	1		00			0
DGPS Timeout	1		1E	seconds		30
Reserved	4					
LP Push-to-Fix	1					
LP On-Time	4					
LP Interval	4					
LP User Tasks Enabled	1					
LP User Task Interval	4					
LP Power Cycling Enabled	1					
LP Max. Acq. Search Time	4					
LP Max. Off Time	4					
Reserved	4					
Reserved	4					

Payload Length: 65 bytes

1. See Table 22.

2. See Table 24.

3. See Table 26.

Navigation Library Measurement Data - Message I.D. 28

Output Rate: Every measurement cycle (full power / continuous : 1Hz)

Example:

A0A20038—Start Sequence and Payload Length

1C00000660D015F143F62C4113F42FF3FB E95E417B235C468C6964B8FBC5824 15CF1C375301734.....03E801F400000000 —Payload

1533B0B3—Message Checksum and End Sequence

Table B- 54 Measurement Data

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		1C			28
Channel	1		00			
Time Tag	4		000660D0	ms		
Satellite ID	1		15			
GPS Software Time	8		F143F62C 4113F42F	ms		
Pseudo Range	8		F3FBE95E 417B235C	m		
Carrier Frequency	4		468C6964			
Carrier Phase	8		B8FBC582 415CF1C3			
Time in Track	2		7530	ms		
Sync Flags	1		17			
C/No1	1		34			
C/No2	1					
C/No3	1					
C/No4	1					
C/No5	1					
C/No6	1					
C/No7	1					
C/No8	1					
C/No9	1					
C/No10	1					
Delta Range Interval	2		03E801F4	m		
Mean Delta Range Time	2		01F4	ms		
Extrapolation Time	2		0000	ms		
Phase Error Count	1		00			
Low Power Count	1		00			

Payload Length: 56 bytes

Navigation Library DGPS Data - Message I.D. 29

Output Rate: Every measurement cycle (full power / continuous : 1Hz)

Example:

A0A2001A—Start Sequence and Payload Length

1D000F00B501BFC97C673CAAAAAB3FBF FE1240A0000040A00000—Payload

0956B0B3—Message Checksum and End Sequence

Table B- 55 Measurement Data

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		1D			29
Satellite ID	2		000F			15
IOD	2		00B5			181
Source[1]	1		01			1

Pseudo-range Correction	4		BFC97C67	m		3217652839
Pseudo-range Rate Correction	4		3CAAAAAB	m/s		1017817771
Correction Age	4		3FBFFE12	s		1069547026
Reserved	4					
Reserved	4					

Payload Length: 26 bytes

1. 0 = Use no corrections, 1 = Use WAAS channel, 2 = Use external source, 3 = Use Internal Beacon, 4 = Set DGPS Corrections

Navigation Library SV State Data - Message I.D. 30

Output Rate: Every measurement cycle (full power / continuous : 1Hz)

Example:

A0A20053—Start Sequence and Payload Length

1E15....2C64E99D01....408906C8—Payload

2360B0B3—Message Checksum and End Sequence

Table B- 56 SV State Data

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		1E			30
Satellite ID	1		15			21
GPS Time	8			s		
Position X	8			m		
Position Y	8			m		
Position Z	8			m		
Velocity X	8			m/s		
Velocity Y	8			m/s		
Velocity Z	8			m/s		
Clock Bias	8			s		
Clock Drift	4		2C64E99D	s		744810909
Ephemeris Flag[1]	1		01			1
Reserved	8					
Ionospheric Delay	4		408906C8	m		1082721992

Payload Length: 83 bytes

1. 0 = no valid SV state, 1 = SV state calculated from ephemeris, 2 = Satellite state calculated from almanac

Navigation Library Initialization Data - Message I.D. 31

Output Rate: Every measurement cycle (full power / continuous : 1Hz)

Example:

A0A20054—Start Sequence and Payload Length

1F....00000000000001001E000F....00....000000000F....00....02....043402....

....02—Payload

0E27B0B3—Message Checksum and End Sequence

Table B- 57 Measurement Data

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		1F			31
Reserved	1					

Altitude Mode[1]	1		00			0
Altitude Source	1		00			0
Altitude	4		00000000			0
Degraded Mode[2]	1		01			1
Degraded Timeout	2		001E			30
Dead-Reckoning Timeout	2		000F			15
Reserved	2					
Track Smoothing Mode[3]	1		00			0
Reserved	1					
Reserved	2					
Reserved	2					
Reserved	2					
DGPS Selection[4]	1		00			0
DGPS Timeout	2		0000			0
Elevation Nav. Mask	2		000F			15
Reserved	2					
Reserved	1					
Reserved	2					
Reserved	1					
Reserved	2					
Static Nav. Mode[5]	1		00			0
Reserved	2					
Position X	8					
Position Y	8					
Position Z	8					
Position Init. Source[6]	1		02			2
GPS Time	8					
GPS Week	2		0434			1076
Time Init. Source [7]	1		02			2
Drift	8					
Drift Init. Source [8]	1		02			2

Payload Length: 84 bytes

1. 0 = Use last know altitude 1 = Use user input altitude 2 = Use dynamic input from external source
2. 0 = Use direction hold and then time hold
   1 = Use time hold and then direction hold
   2 = Only use direction hold
   3 = Only use time hold
   4 = Degraded mode is disabled
3. 0 = True and 1 = False
4. 0 = Use DGPS if available
   1 = Only navigate if DGPS corrections are available
   2 = Never use DGPS corrections
5. 0 = True 1 = False
6. 0 = ROM position
   1 = User position
   2 = SRAM position
   3 = Network assisted position
7. 0 = ROM time
   1 = User time
   2 = SRAM time
   3 = RTC time
   4 = Network assisted time
8. 0 = ROM clock
   1 = User clock
   2 = SRAM clock
   3 = Calibration clock
   4 = Network assisted clock

RoyalTek Navigation Data – Message I.D.100

Output Rate: 1Hz and Payload Length

Example :A0A2001A – Start Sequence 6407D1*********** - Payload

****B0B3 – Message checksum and End Sequence

Table 57 Royaltek Navigation Data

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		64			100
Year	2		07D1			2001
Month	2		000C			12
Day	2		0005			5
Hours	2		0011			17
Minutes	2		001E			30
Seconds	4	*1000	5202	Sec.	÷1000	20.994
Degree of Latitude	2		19	degree		25
Minutes of Latitude	4	*10000	0001818C	Min.	÷10000	9.8700
Degree of Longitude	2		79	degree		121
Minute of Longitude	4	*10000	0002BA64	Min.	÷10000	17.8788
Altitude	4		000000FA	meter		250
Validity	1		01			1
Speed	2	*10	0064	Km/h	÷10	10.0
Course over ground	2		0080	Degree		128
PDOP	2	*10	012C		÷10	30.0
HDOP	2	*10	012C		÷10	30.0
VDOP	2	*10	012C		÷10	30.0

Payload Length: 42 bytes. This protocol is provided from RoyalTek firmware Ver. 1.7. release

* *hh<CR><LF> Check Sum and sentence termination delimiter

Set Ephemeris – Message I.D.254

This command enables the user to upload an ephemeris to the Evaluation unit.

Note – This feature is not documented in this manual . For information on implementation contact SiRF Technology Inc.

Development Data – Message I.D.255

Output Rate: Receiver generated

Example :A0A2**** - Start Sequence and Payload Length

FF************** - Payload

****B0B3 – Message Checksum and End Sequence

Table 58 Development Data

Name	Bytes	Binary(Hex)		Units	ASCII(Decimal)	
		Scale	Example		Scale	Example
Message ID	1		FF			255

Payload Length:Variable

Note – Messages are output to give the user information of receiver activity. Convert to symbol to assemble message (i.e., 0x4E is 'N') these are low priority task and are not necessarily output at constant intervals.

GPS Receiver User's Tip

1. GPS signal will be affected by weather and environment conditions, thus suggest to use the GPS receiver under less shielding environments to ensure GPS receiver has better receiving performance.

2. When GPS receiver is moving, it will prolong the time to fix the position, so suggest to wait for the satellite signals to be locked at a fixed point when first power-on the GPS receiver to ensure to lock the GPS signal at the shortest time.

3. The following situation will affect the GPS receiving performance:
   a. Solar control filmed windows.
   b. Metal shielded, such as umbrella, or in vehicle.
   c. Among high buildings.
   d. Under bridges or tunnels.
   e. Under high voltage cables or near by radio wave sources, such as mobile phone base stations.
   f. Bad or heavy cloudy weather.
4. If the satellite signals can not be locked or encounter receiving problem (while in the urban area), the following steps are suggested:
   a. Please plug the external active antenna into GPS receiver and put the antenna on outdoor or the roof of the vehicle for better receiving performance.
   b. Move to another open space or reposition GPS receiver toward the direction with less blockage.
   c. Move the GPS receiver away from the interferences resources.
   d. Wait until the weather condition is improved.
5. While a GPS with a backup battery, the GPS receiver can fix a position immediately at next power-on if the build-in backup battery is full-recharged.

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